

**Interactive Classroom**

**Glencoe Science**

# CHEMISTRY

MATTER AND CHANGE

## Chapter 6

The Periodic Table and  
Periodic Law

**Mc  
Graw  
Hill** **Glencoe**

Click the mouse button or press the Space Bar to continue.

## Section 6.3 Periodic Trends

### Objectives

- **Compare** period and group trends of several properties.
- **Relate** period and group trends in atomic radii to electron configuration.

### Review Vocabulary

**principal energy level:**  
the major energy level of an atom

### New Vocabulary

ion

ionization energy

octet rule

electronegativity

### MAIN Idea

Trends among elements in the periodic table include their size and their ability to lose or attract electrons



## Atomic Radius

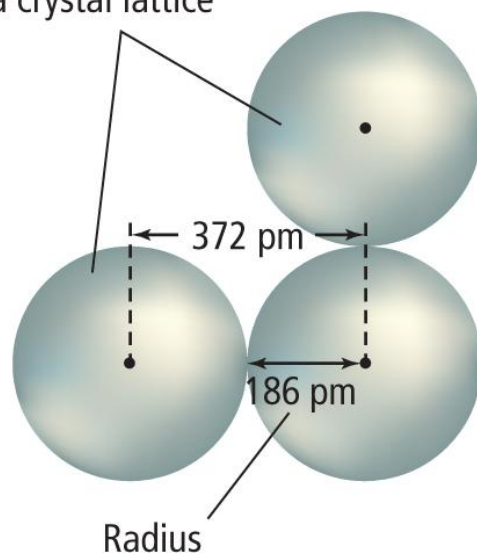
- Atomic size is a periodic trend influenced by electron configuration.
- For metals, atomic radius is half the distance between adjacent nuclei in a crystal of the element.



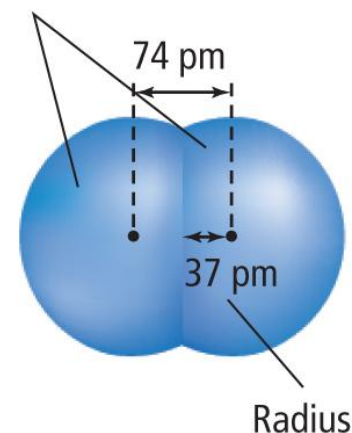
## Atomic Radius (cont.)

- For elements that occur as molecules, the atomic radius is half the distance between nuclei of identical atoms.

Bonded metallic  
sodium atoms in  
a crystal lattice



Bonded nonmetal hydrogen  
atoms in a molecule

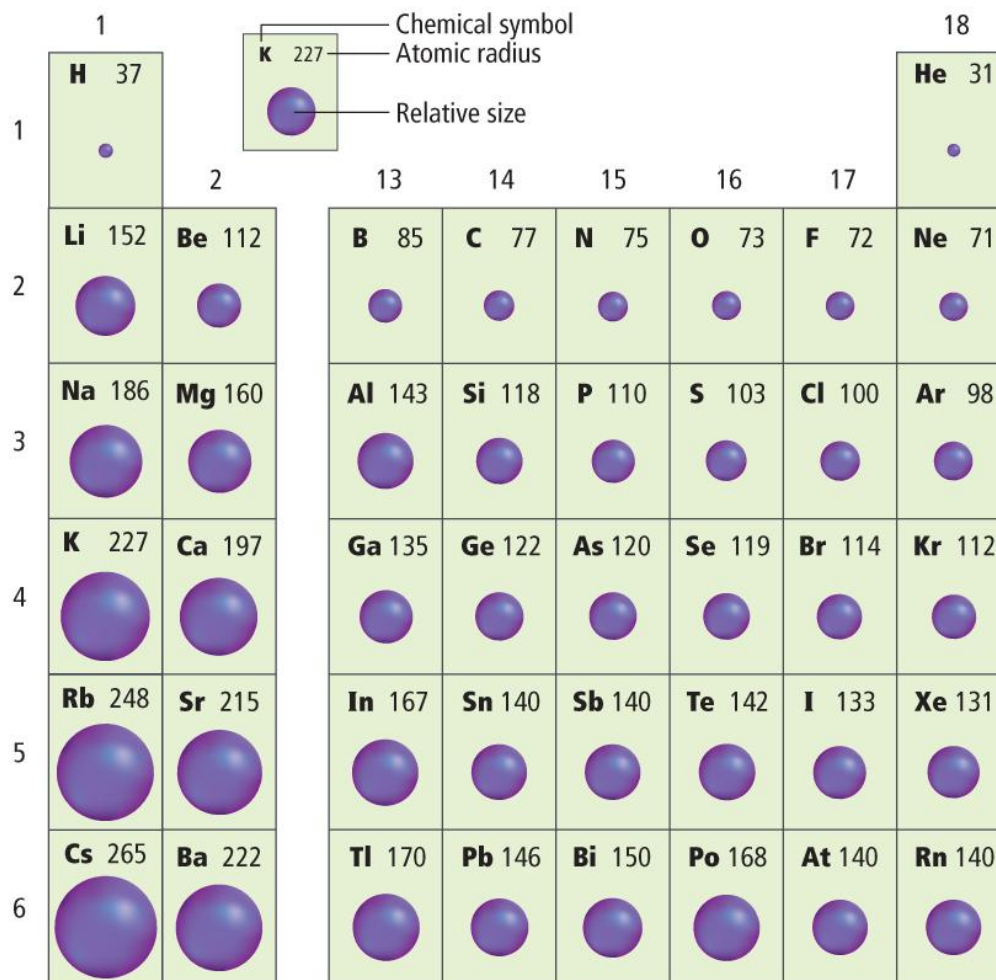


## Atomic Radius (cont.)

- There is a general decrease in atomic radius from left to right, caused by increasing positive charge in the nucleus.
- Valence electrons are not shielded from the increasing nuclear charge because no additional electrons come between the nucleus and the valence electrons.



## Atomic Radius (cont.)



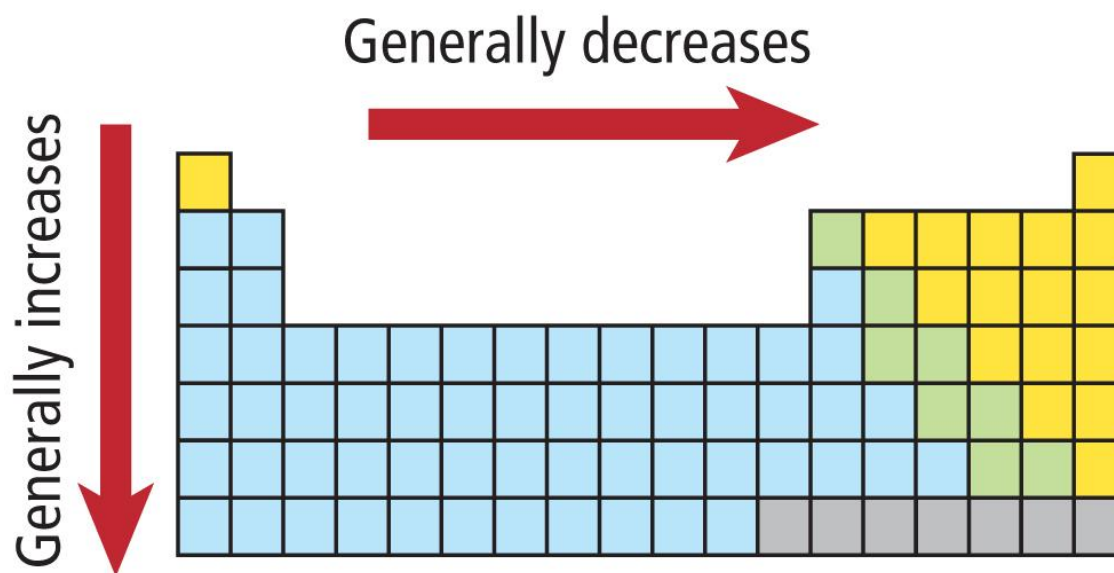
**Concepts In Motion**

Click here to view an animated version of this graphic.



## Atomic Radius (cont.)

- Atomic radius generally increases as you move down a group.
- The outermost orbital size increases down a group, making the atom larger.



Trends in Atomic Radii



## Ionic Radius

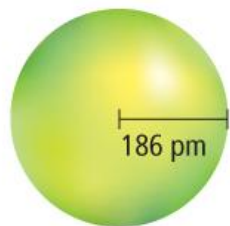
- An ion is an atom or bonded group of atoms with a positive or negative charge.
- When atoms lose electrons and form positively charged ions, they always become smaller for two reasons:
  1. The loss of a valence electron can leave an empty outer orbital resulting in a small radius.
  2. Electrostatic repulsion decreases allowing the electrons to be pulled closer to the nucleus.



## Ionic Radius (cont.)

- When atoms gain electrons, they can become larger, because the addition of an electron increases electrostatic repulsion.

a

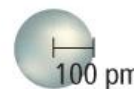


Sodium atom (Na)  
[Ne]3s<sup>1</sup>

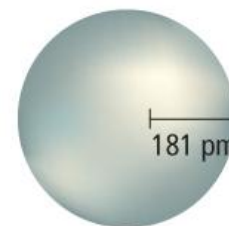


Sodium ion (Na<sup>+</sup>)  
[Ne]

b



Chlorine atom (Cl)  
[Ne]3s<sup>2</sup>3p<sup>5</sup>

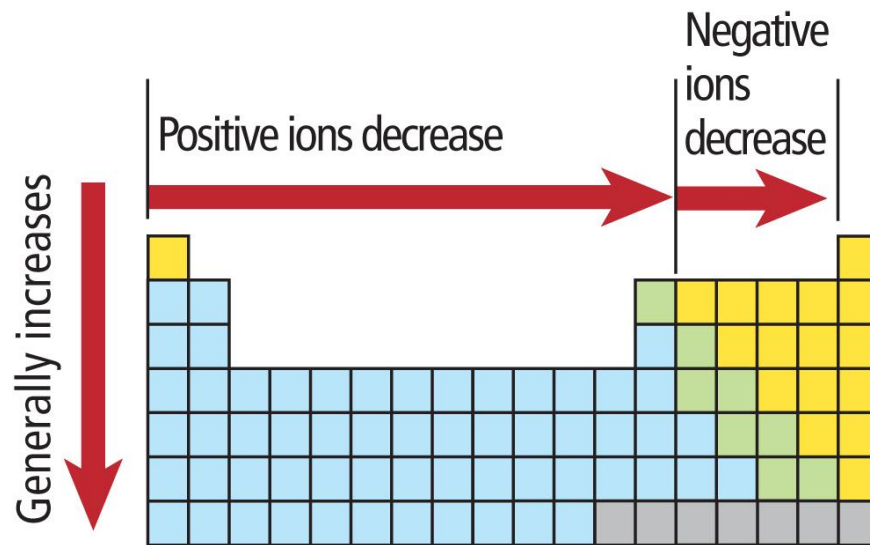


Chlorine ion (Cl<sup>-</sup>)  
[Ne]3s<sup>2</sup>3p<sup>6</sup> or [Ar]



## Ionic Radius (cont.)

- The ionic radii of positive ions generally decrease from left to right.
- The ionic radii of negative ions generally decrease from left to right, beginning with group 15 or 16.




































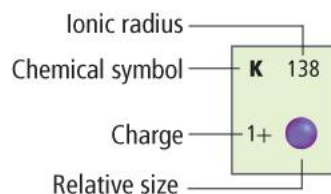
Trends in Ionic Radii



# Ionic Radius (cont.)

- Both positive and negative ions increase in size moving down a group.

	1	2	13	14	15	16	17
2	<b>Li</b> 76 1+ 	<b>Be</b> 31 2+ 	<b>B</b> 20 3+ 	<b>C</b> 15 4+ 	<b>N</b> 146 3- 	<b>O</b> 140 2- 	<b>F</b> 133 1- 
3	<b>Na</b> 102 1+ 	<b>Mg</b> 72 2+ 	<b>Al</b> 54 3+ 	<b>Si</b> 41 4+ 	<b>P</b> 212 3- 	<b>S</b> 184 2- 	<b>Cl</b> 181 1- 
4	<b>K</b> 138 1+ 	<b>Ca</b> 100 2+ 	<b>Ga</b> 62 3+ 	<b>Ge</b> 53 4+ 	<b>As</b> 222 3- 	<b>Se</b> 198 2- 	<b>Br</b> 195 1- 
5	<b>Rb</b> 152 1+ 	<b>Sr</b> 118 2+ 	<b>In</b> 81 3+ 	<b>Sn</b> 71 4+ 	<b>Sb</b> 62 5+ 	<b>Te</b> 221 2- 	<b>I</b> 220 1- 
6	<b>Cs</b> 167 1+ 	<b>Ba</b> 135 2+ 	<b>Tl</b> 95 3+ 	<b>Pb</b> 84 4+ 	<b>Bi</b> 74 5+ 		

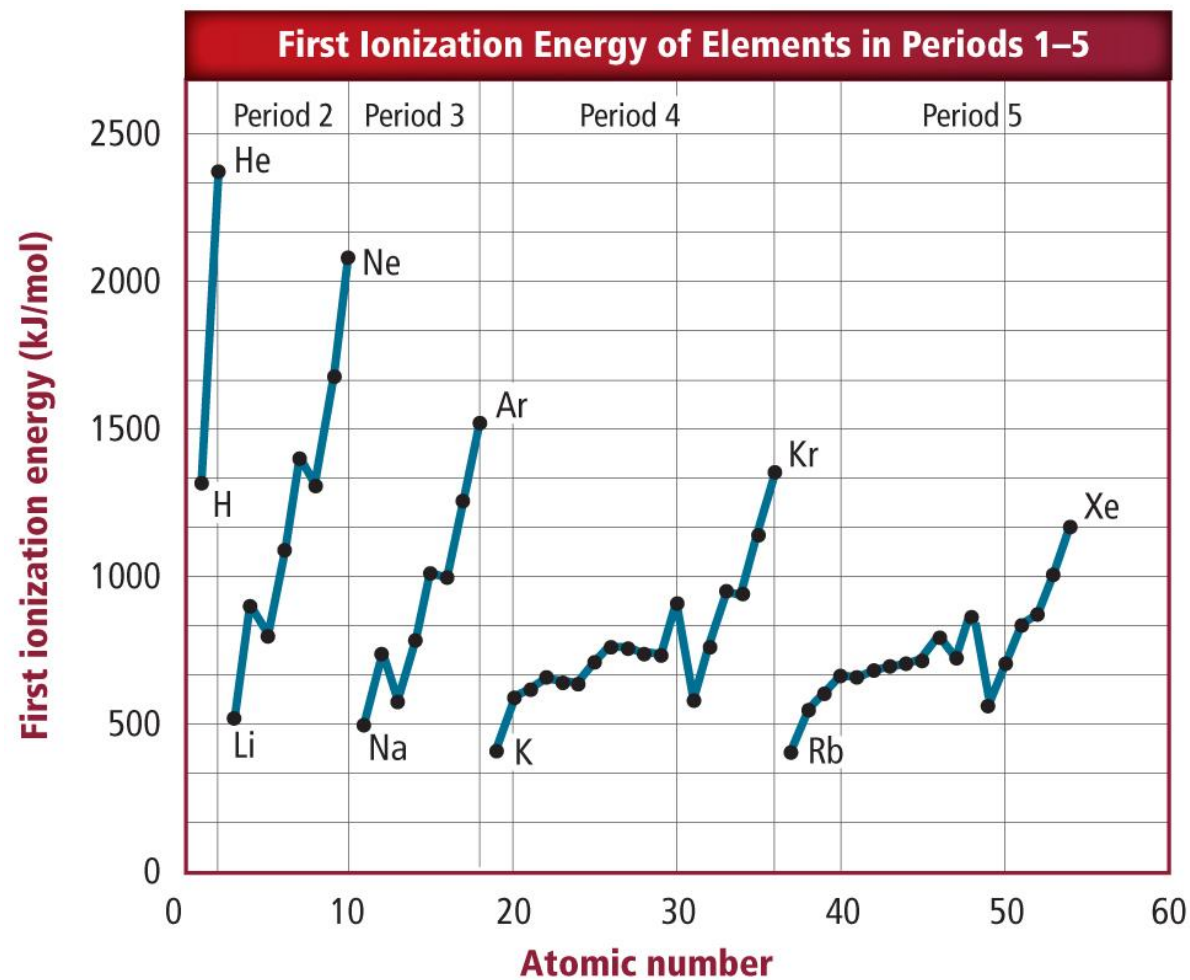


## Ionization Energy

- **Ionization energy** is defined as the energy required to remove an electron from a gaseous atom.
- The energy required to remove the first electron is called the first ionization energy.



# Ionization Energy (cont.)



## **Ionization Energy** (cont.)

- Removing the second electron requires more energy, and is called the second ionization energy.
- Each successive ionization requires more energy, but it is not a steady increase.



# Ionization Energy (cont.)

**Table 6.5****Successive Ionization Energies  
for the Period 2 Elements**

Element	Valence Electrons	Ionization Energy (kJ/mol)*								
		1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	5 <sup>th</sup>	6 <sup>th</sup>	7 <sup>th</sup>	8 <sup>th</sup>	9 <sup>th</sup>
Li	1	520	7300							
Be	2	900	1760	14,850						
B	3	800	2430	3660	25,020					
C	4	1090	2350	4620	6220	37,830				
N	5	1400	2860	4580	7480	9440	53,270			
O	6	1310	3390	5300	7470	10,980	13,330	71,330		
F	7	1680	3370	6050	8410	11,020	15,160	17,870	92,040	
Ne	8	2080	3950	6120	9370	12,180	15,240	20,000	23,070	115,380

\* mol is an abbreviation for mole, a quantity of matter.

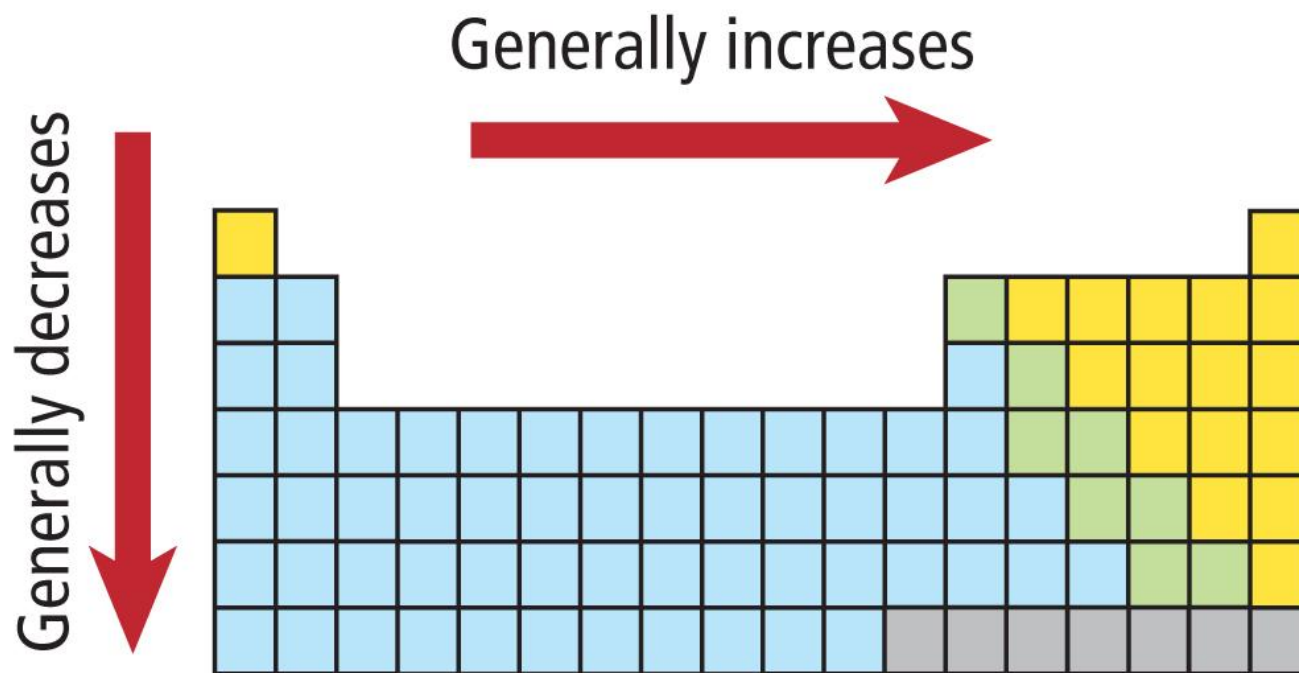


## **Ionization Energy** (cont.)

- The ionization at which the large increase in energy occurs is related to the number of valence electrons.
- First ionization energy increases from left to right across a period.
- First ionization energy decreases down a group because atomic size increases and less energy is required to remove an electron farther from the nucleus.



# Ionization Energy (cont.)



Trends in First Ionization  
Energies



## **Ionization Energy** (cont.)

- The **octet rule** states that atoms tend to gain, lose or share electrons in order to acquire a full set of eight valence electrons.
- The octet rule is useful for predicting what types of ions an element is likely to form.

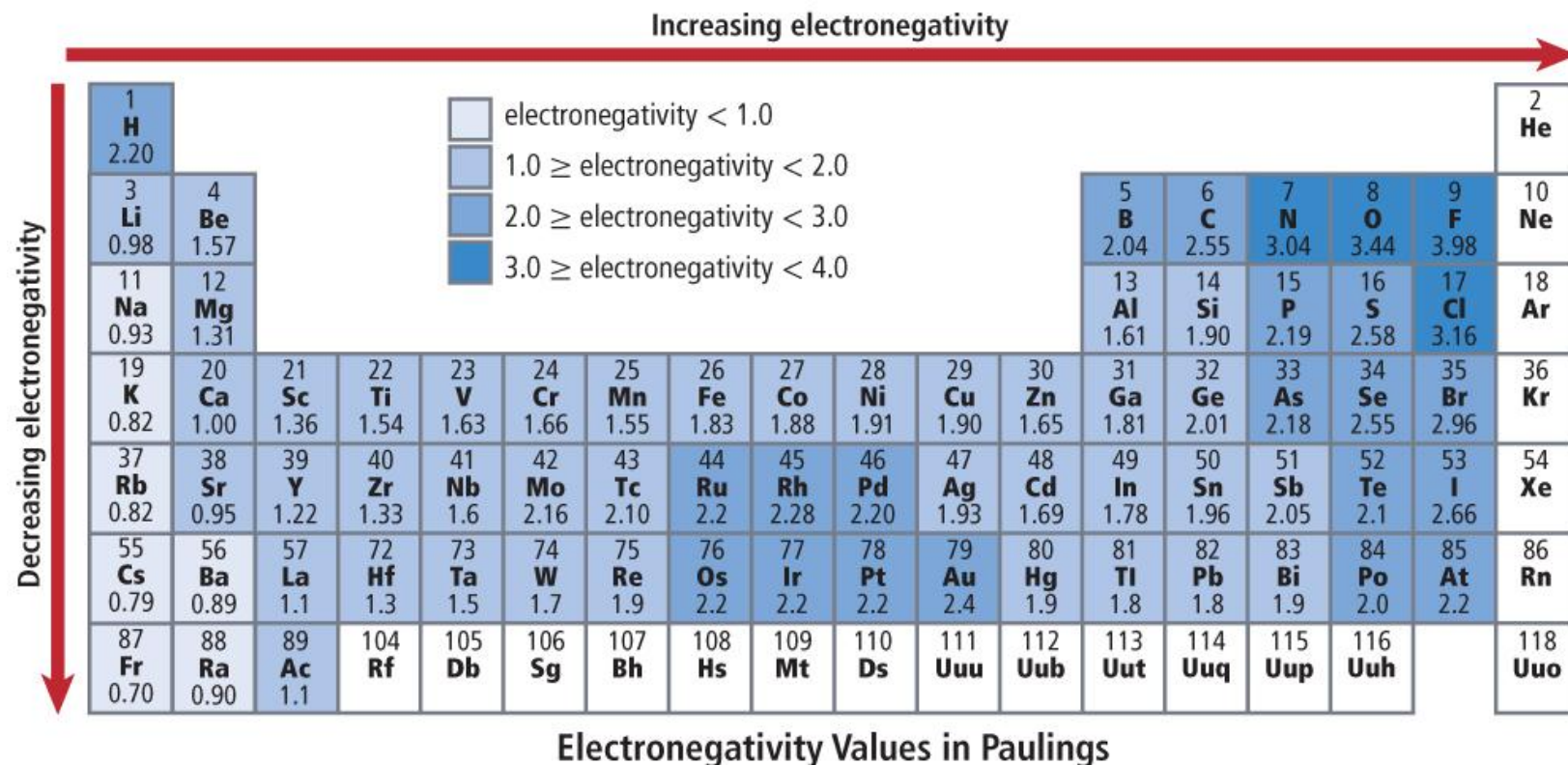


## Ionization Energy (cont.)

- The electronegativity of an element indicates its relative ability to attract electrons in a chemical bond.
- Electronegativity decreases down a group and increases left to right across a period.



# Ionization Energy (cont.)



## Section 6.3 Assessment



The lowest ionization energy is the \_\_\_\_.

- A.** first
- B.** second
- C.** third
- D.** fourth



## Section 6.3 Assessment



**The ionic radius of a negative ion becomes larger when:**

- A. moving up a group
- B. moving right to left across period
- C. moving down a group**
- D. the ion loses electrons

